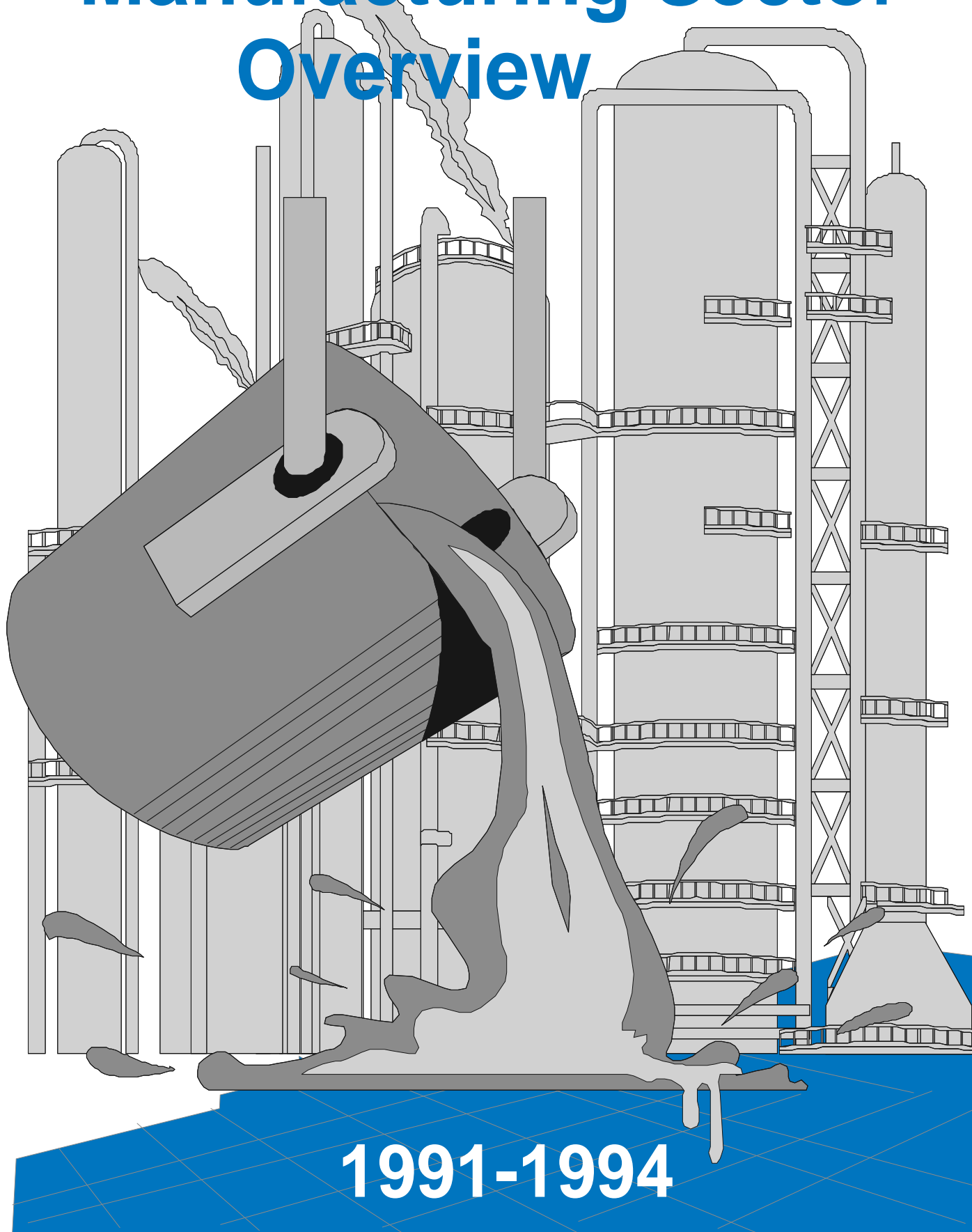


Manufacturing Sector Overview

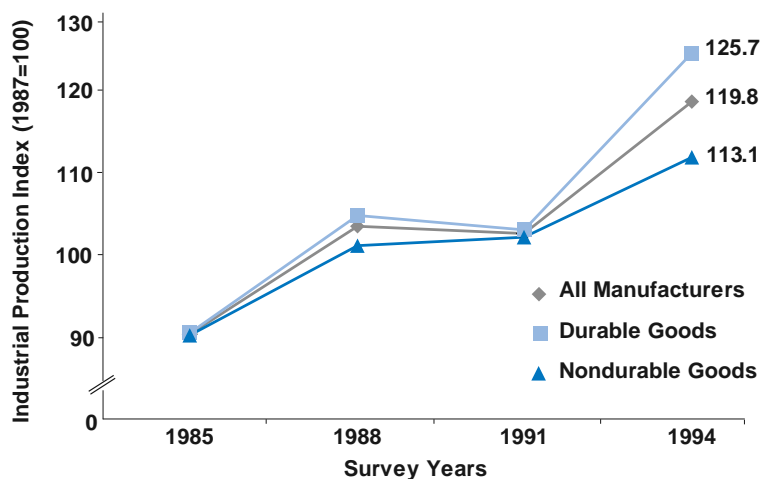


○ What Took Place in the Economic Environment Between 1991 and 1994 That Affected the Energy Manufacturers Used ?

In 1991, output in the manufacturing sector fell as the country went into a recession. After 1991, however, output increased as the country slowly came out of the recession. Between 1991 and 1994, manufacturers, especially manufacturers of durable goods such as steel and glass, experienced strong growth. The industrial production index for durable goods during the period increased by 21 percent. Real gross domestic product for durable goods increased a corresponding 16 percent. The growth of nondurables was not as strong--the production index increased by only 9 percent during this time period.

As production grew, the prices manufacturers had to pay for both material inputs and wages experienced very little growth. One measure of labor productivity, the output per hour index, increased during this time period by 11 percent.

Industrial Production, 1985, 1988, 1991, and 1994



Source: U.S. Federal Reserve Board, Statistical Release G-17. Online. (<http://www.bog.frb.us/release/G17>). (November 27, 1996).

Manufacturing Indicators (Percent Change 1991 to 1994)

Industrial Production Index

Manufacturing	15	↑
Durables	21	↑↑
Nondurables	9	↑

Real Gross Domestic Product

Manufacturing	11	↑
Durables	16	↑↑
Nondurables	6	↑

Producer Price Index

Intermediate Materials	4	↑
Crude Materials	0	

Real Hourly Compensation Index

Manufacturing	2	↑
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Output per Hour Index

Manufacturing	11	↑
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Sources: ● **Industrial Production**: Federal Reserve Board, Statistical Release G-17. Online. (<http://www.bog.frb.fed.us/release/G17>). (November 27, 1996). ● **Real Gross Domestic Product, Producer Price, Real Hourly Compensation, and Output per Hour Indices**: U.S. Bureau of the Census, *Statistical Abstract of the United States: 1996* (116th edition) (Washington, DC, 1996), Tables 685, 751, 218, and 665.

○ Why Do We Investigate Energy Use in the Manufacturing Sector?

It is in the context of this economic environment that the Energy Information Administration (EIA) investigates energy use in the manufacturing sector for the years 1991 and 1994. Energy costs may be only a small percentage of the total cost of production for manufacturers in general--so why bother investigating energy use by manufacturers? Energy use is important to manufacturers. Energy costs are substantial for manufacturers such as the chemical, paper, and petroleum refining industry groups. Additionally, in the low-inflation environment of the early 1990's, manufacturers, holding the line on prices for their goods, looked at all of their inputs, including their energy inputs, for cost reductions. From a national view, manufacturing energy use is important. Environmental and energy security concerns increase the importance of our investigation. A clearer understanding of how energy is used can also help the Nation anticipate how future expansion of the manufacturing sector might affect future energy needs.

○ What Data Do EIA Use To Investigate Energy Use in the Manufacturing Sector?

Most of the data used in this investigation were collected as part of two mail establishment surveys, the 1991 and 1994 Manufacturing Energy Consumption Survey (MECS) conducted by EIA. The survey, the most comprehensive source of national-level data on energy-related information, was designed to contribute to the understanding of energy usage in the sector. The 1994 MECS is the focus of this report. Previous surveys were conducted in 1985 and 1988.

● How Is the Manufacturing Sector Classified?

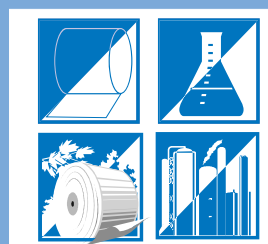
The manufacturing sector encompasses a wide variety of production activity, and, as such, accounts for a major part of the diversity in U.S. economic activity. The current definitive classification of the entire range of U.S. economic activity is the 1987 Standard Industrial Classification (SIC) System, which defines industries in accordance with the composition and structure of the economy. In the manufacturing sector, each establishment (see glossary for definition) is placed in a category associated with the types of goods it primarily produces.

Future MECS samples will conform to the recently developed North American Industrial Classification System (NAICS) developed by the Office of Management and Budget (OMB), Executive Office of the President, which will replace the 1987 SIC. The NAICS is the first industry classification system developed in accordance with the principle of aggregation, whereby producing units that use similar production processes are grouped together in the classification.

In accordance with OMB guidance, industry breakdowns of data will be tabulated according to the NAICS starting with the 1998 MECS. Along with the new industry breakdown, comparable estimates of energy measures will be prepared according to the 1987 SIC, so that data users can understand the effects of the new system.

20 Major Groups (two-digit)

The broadest classification level contains 20 major groups (SIC 20 through 39). The four largest energy consumers are Paper and Allied Products (SIC 26), Chemicals and Allied Products (SIC 28), Petroleum and Coal Products (SIC 29), and Primary Metal Industries (SIC 33). The MECS reports on all 20 two-digit SIC groups.



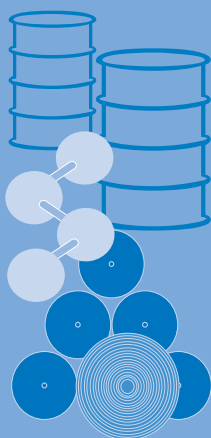
139 Industry Groups (three-digit)

The 20 major groups are subdivided into 139 three-digit industry groups (SIC 201 through SIC 399). At this level, the MECS reports only on three three-digit industries: Miscellaneous Plastic Products (SIC 308), Blast Furnace and Basic Steel Products (SIC 331), and Computer and Office Equipment (SIC 357).

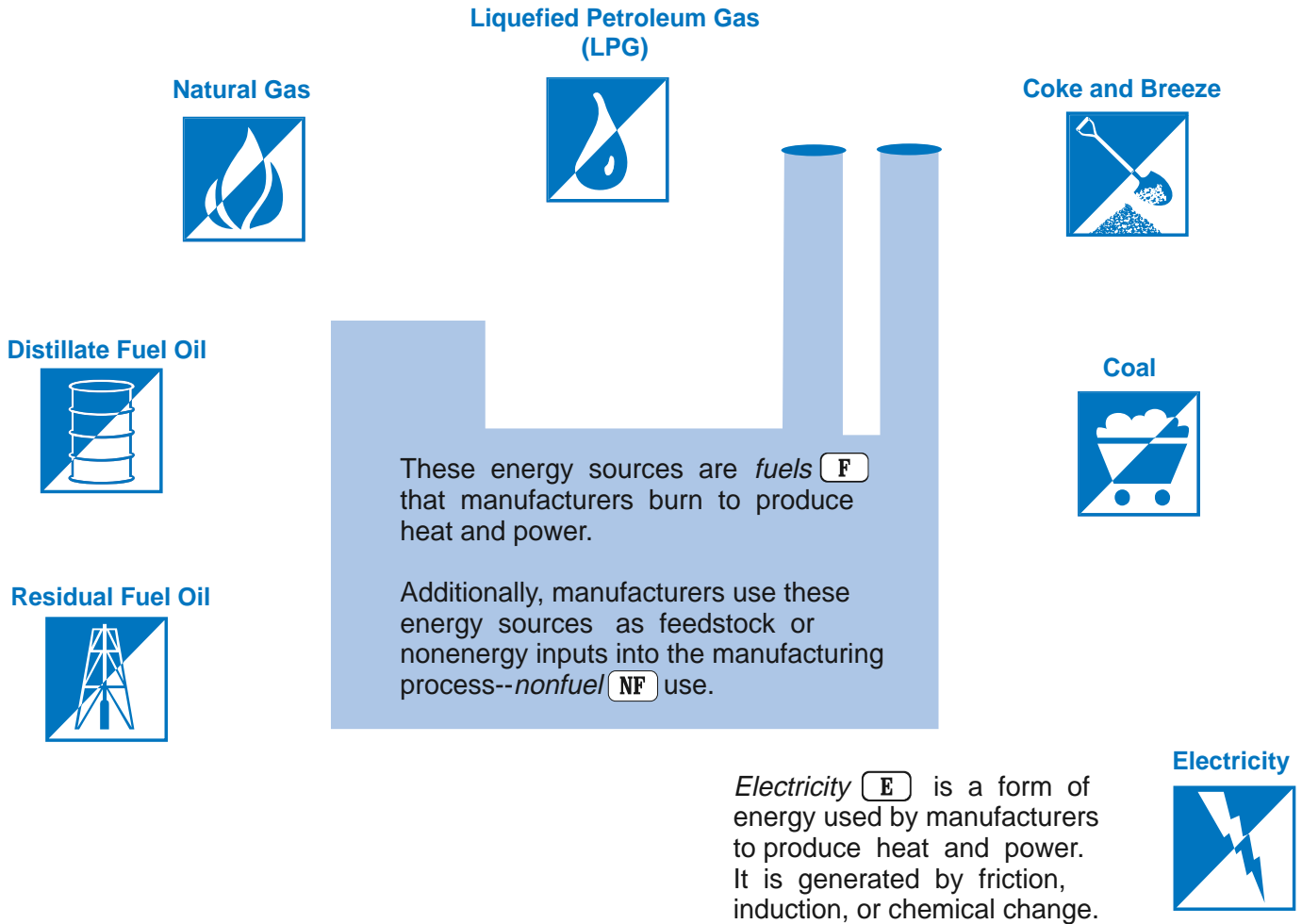


459 Industries (four-digit)

The 139 industry groups are further subdivided into 459 four-digit industry groups (SIC 2011 through SIC 3999). The 1994 MECS reports only on 49 four-digit industries that are the largest energy consuming industries--most have historically consumed most of the energy used in the manufacturing sector. The four largest energy-users in this group are Paper Mills (SIC 2621), Organic Chemicals not elsewhere classified (SIC 2869), Petroleum Refining (2911), and Blast Furnaces and Steel Mills (SIC 3312).



○ What Common Energy Sources Do Manufacturers Use?



Other Energy Sources Used in the Manufacturing Sector

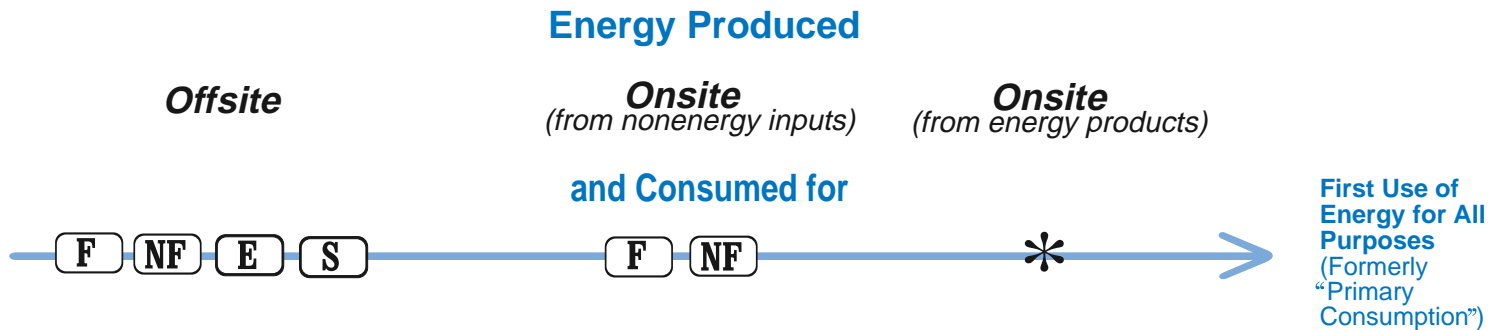
Manufacturing establishments also use large quantities of steam **(S)**. Most of the steam used is produced from the combustion of energy sources in onsite boilers. Because these energy sources are already counted as boiler fuel, they are not counted again in the MECS. Electricity that is generated onsite from combustible energy sources also is not counted for the same reason--to avoid duplication. The quantity of steam and electricity that is counted is the quantity produced offsite plus the quantity produced from renewable energy (hydropower, solar power, wind energy, and geothermal energy) minus sales and transfers leaving the establishment.

Manufacturers use energy sources that are not commonly used by other sectors, such as wood chips, bark, and wood waste materials produced during the preparation of wood pulping. The pulping process itself produces an energy source known as pulping liquor, or black liquor, which is also consumed as fuel. Other sources uncommon in the other sectors include blast furnace or coke oven gas resulting from the production of coke from coal, as well as petroleum coke and still gas produced at petroleum refineries. These are called “byproducts” because they result from the feedstock use of energy or the processing of nonenergy materials.

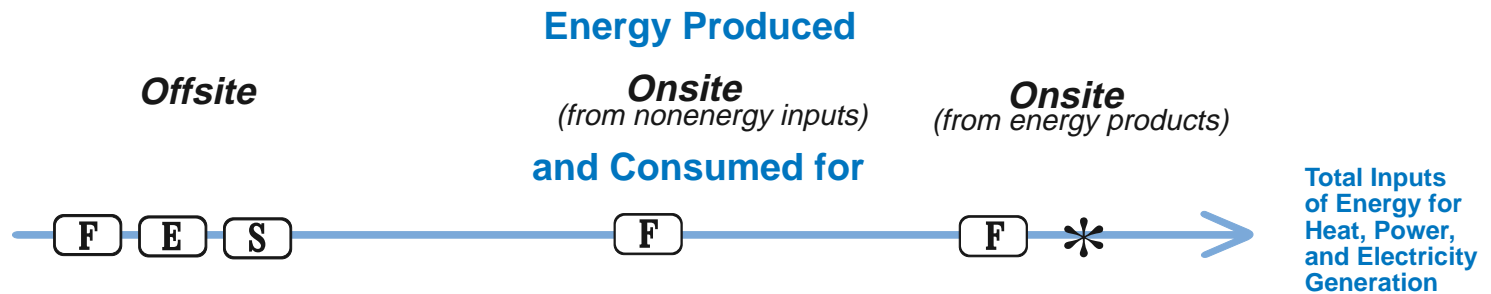
In addition, certain manufacturers consume biomass (such as rice hulls), packing crates, and other similar materials as energy sources.

Manufacturing Sector:

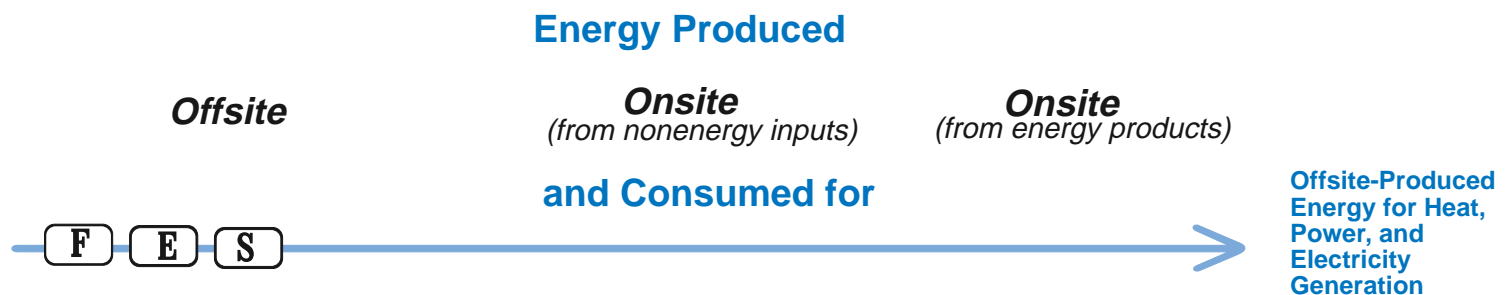
● How Does EIA Measure Energy in the Manufacturing Sector?



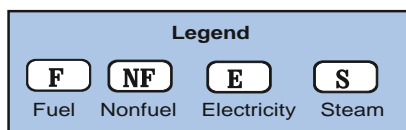
The First Use of Energy for All Purposes includes all energy used in the manufacturing sector for two purposes--for heat, power, and electricity generation and as a nonenergy use (feedstock). Excluded are: (1) electricity generated by the establishment using a combustible fuel; (2) byproduct fuels produced onsite from energy inputs, such as coke from metallurgical coal; and (3) refinery crude oil inputs that end up as energy products sold to and used by other sectors. Refined products and byproducts used by the refinery are counted, as well as the energy content of products created for their physical or chemical properties rather than for their energy content such as waxes, asphalt, and lubricants. Steam is included under "Other."



Total Inputs of Energy for Heat, Power, and Electricity Generation includes energy used for heat, power, and electricity generation and byproduct fuels. Feedstock is excluded from this measure. Steam is included under "Other."



Offsite-Produced Energy for Heat, Power, and Electricity Generation includes all energy used for heat, power, and electricity generation purchased by the establishment or transferred into the establishment. Also included is steam that has been purchased or transferred from offsite. Feedstock and onsite-produced energy are excluded from this measure. Purchased steam is included under "Other."



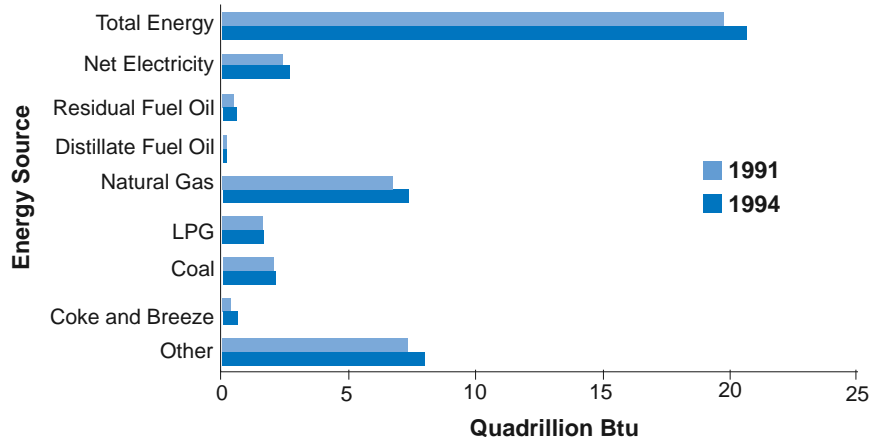
* Steam and electricity generated from renewables minus all sales and transfers offsite of steam and electricity, regardless of origin.

EIA Measures of Energy

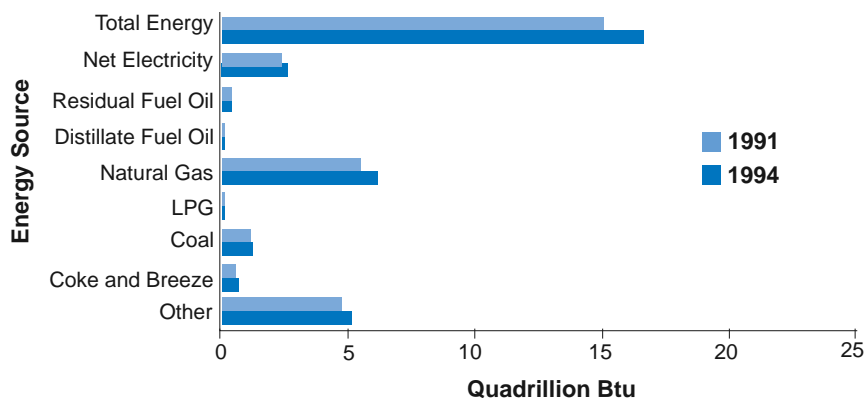
● How Much Energy Did the Sector Consume in 1991 and 1994?

Improvements in the economic conditions in the manufacturing sector between 1991 and 1994 are reflected in the 4-percent growth of the most comprehensive measure of energy use, First Use of Energy for All Purposes. The largest percent increases belong to net electricity, natural gas, and coke and breeze, 12 percent, 12 percent, and 47 percent, respectively.

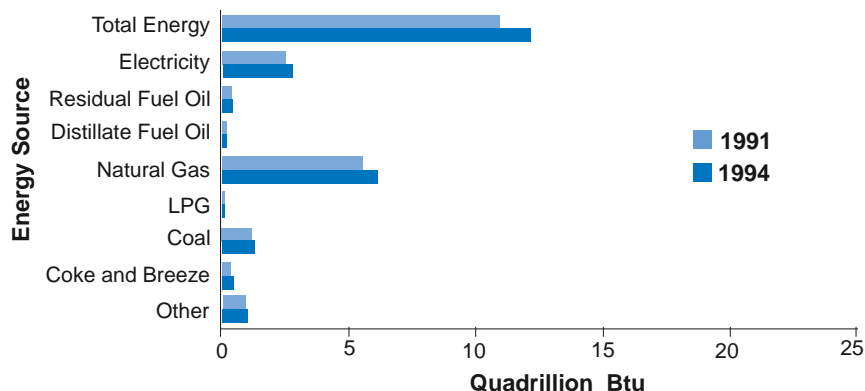
First Use of Energy for All Purposes



Total Inputs of Energy for Heat, Power, and Electricity Generation



Offsite-Produced Energy for Heat, Power, and Electricity Generation



Net electricity, defined as electricity purchased, transferred in, or generated from noncombustible energy sources minus sales and transfers offsite, has two large users. In 1994, out of all of the net electricity in the manufacturing sector, the chemical and the primary metal industries' shares were 20 percent and 19 percent, respectively. Between 1991 and 1994, energy use by the primary metal industries was constant, whereas energy use by the chemical industry grew by 18 percent.

In 1994, **natural gas** accounted for 32 percent of First Use of Energy for All Purposes. Thirty-eight percent of the natural gas was used by the chemical industry. Between 1991 and 1994, the industry increased its natural gas use by 15 percent.

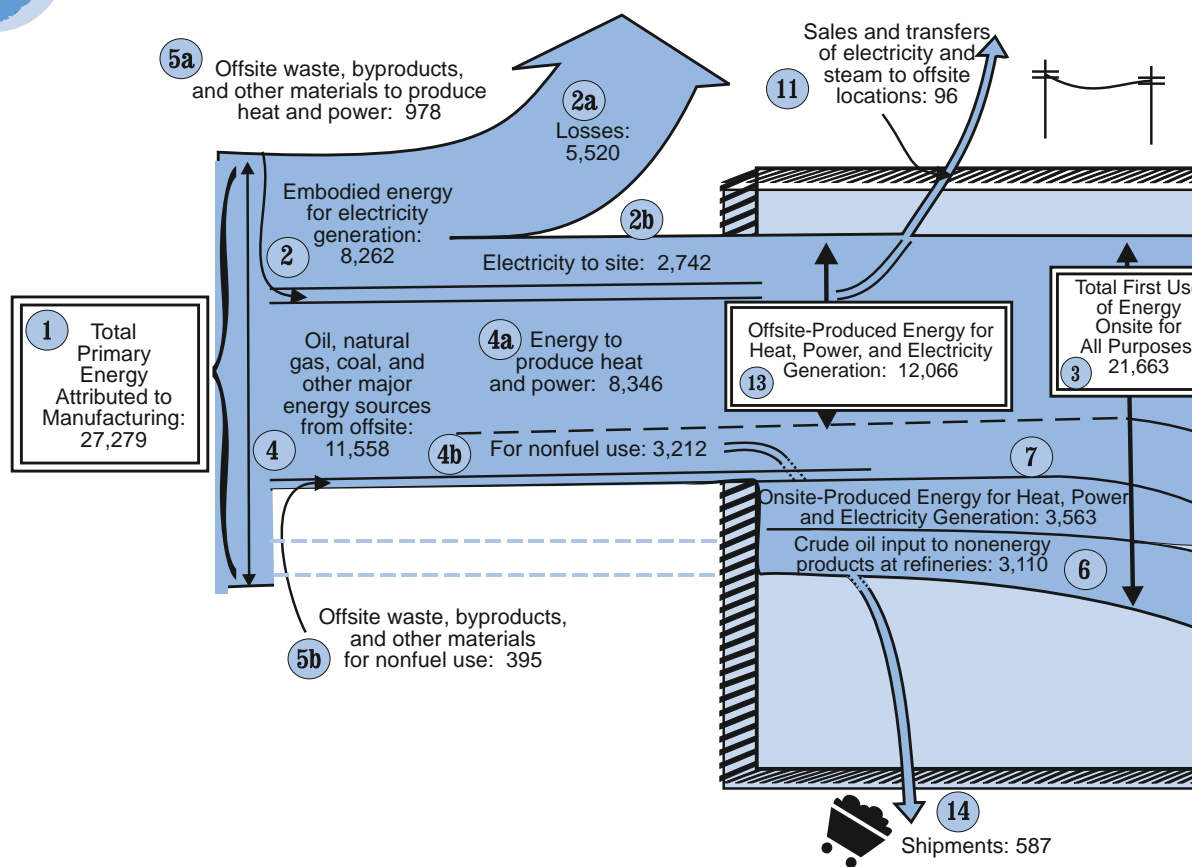
Almost all **coke and breeze** is used in the primary metal industries. From 1991 to 1994, that industry's coke and breeze use increased by 54 percent, led predominately by use in blast furnaces and steel mills. Blast furnaces and steel mills also increased their use of coal by 8.8 percent, indicating that the growth in coke and breeze may not have been a substitution effect, but rather the effect of an increase in output.



Web Site for the Energy Information Administration:
<http://www.eia.doe.gov>

Manufacturing Energy

(Estimates in Trillion Btu)



In 1994, 27.3 quadrillion Btu (quads) of Total Primary Energy can be attributed to the manufacturing sector **(1)**. This amount included 5.5 quads of energy lost in generating and transmitting electricity **(2a)** and 21.7 quads of First Use of Energy for All Purposes **(3)**.¹

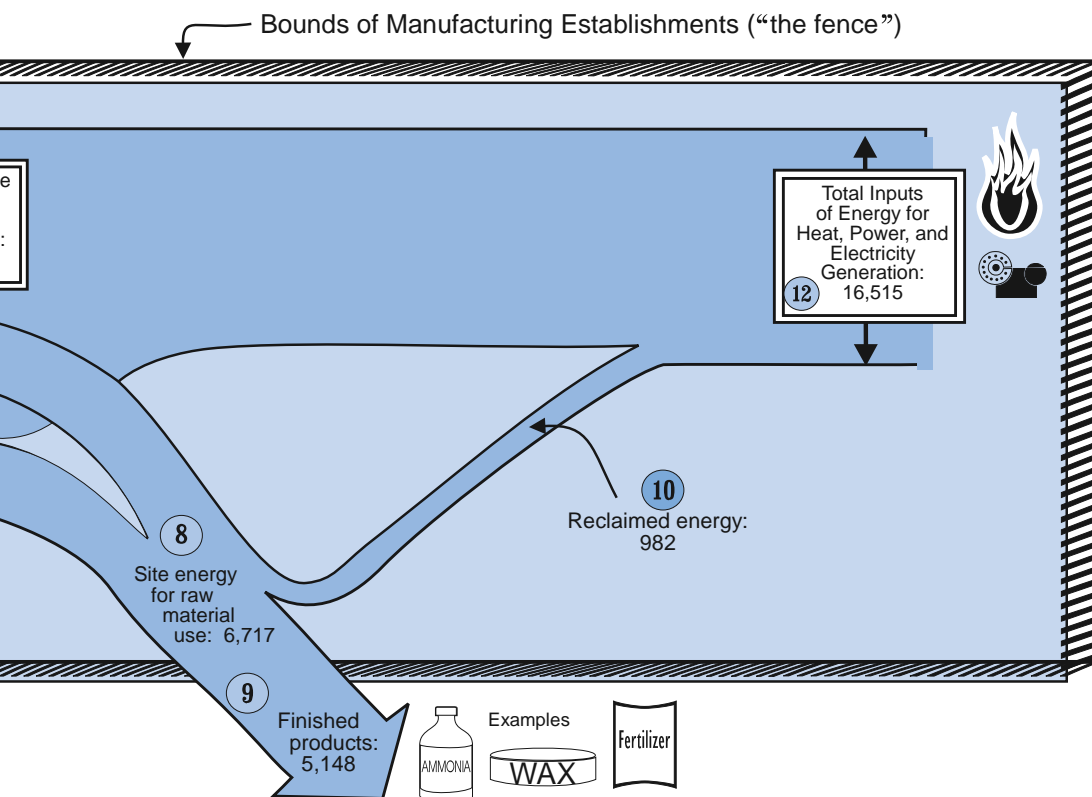
The 21.7 quads of First Use of Energy for All Purposes **(3)** are the sum of:

- The 2.7 quads of electricity delivered to the manufacturing site **(2b)**
- 11.6 quads of natural gas, coal, fuel oil, and other major energy sources **(4)**; with 8.3 quads of this amount being used inside the establishment (the fence) to produce heat and power **(4a)** and 3.2 quads being used for nonfuel uses **(4b)**
- 1.4 quads of offsite waste, byproducts, and other materials **(5a and 5b)**; with .4 quads of this amount being used for nonfuel uses **(5b)**
- 3.1 quads of crude oil input to nonenergy products (such as asphalt and road oil) at refineries **(6)**
- 3.6 quads of onsite-produced energy for heat, power, and electricity (waste and byproducts from onsite processing; energy from mines and wells onsite; and electricity and steam generated onsite from wind, solar, hydropower, and geothermal sources) **(7)**, minus 0.1 quads of sales and transfers of electricity and steam.

The feedstock components of the First Use of Energy for All Purposes measure **(8)** included 3.2 quads of natural gas, coal, fuel oil, and other major energy sources **(4b)**; 0.4 quads of offsite waste, byproducts, and other materials **(5b)**; and 3.1 quads of crude oil input to nonenergy products **(6)**. Of the 6.7 quads of site energy used for feedstock **(8)**, 5.1 quads were used in finished products, such as fertilizer, ammonia, and wax **(9)**, and 1.6 quads were reclaimed for use in producing heat and power, and generating electricity onsite **(10)**.

Energy Throughput, 1994

(in Quadrillion Btu)



The 16.5 quads of Total Inputs of Energy for Heat, Power, and Electricity Generation **(12)** included:

- 1.0 quads from offsite waste, byproducts, and other materials **(5a)**
- 2.7 quads of electricity delivered to the manufacturing site **(2b)**
- 8.3 quads of oil, natural gas, coal, and other major energy sources produced offsite and used to produce heat and power **(4a)**
- 3.6 quads of onsite-produced energy for heat, power, and electricity (waste and byproducts from onsite processing energy from mines and wells onsite; and electricity and steam generated onsite from wind power, solar power, hydropower, and geothermal energy) **(7)**
- 1.0 quads of energy reclaimed from the byproducts and waste of raw materials produced onsite and used for heat, power, and electricity generation **(10)**.

The 16.5 quads of Total Inputs of Energy for Heat, Power, and Electricity Generation also excluded the 0.1 quad of electricity and steam that was transferred to offsite locations **(11)**.

The 12.1 quads of Offsite-Produced Energy for Heat, Power, and Electricity Generation **(13)** included:

- 2.7 quads of electricity **(2b)**
- 1.0 quads of offsite waste, byproducts, and other materials **(5a)**
- 8.3 quads of oil, natural gas, coal, and other major energy sources from offsite **(4a)**.








¹Components may not sum to totals due to independent rounding.

Source: Energy Information Administration, 1994 Manufacturing Energy Consumption Survey.

● How Did Manufacturers' Energy Prices, Quantities Purchased, and Expenditures in 1994 Compare With Those in 1991? (Annualized Rate Change)








Prices Were Lower for Most of the Purchased Energy Sources

(1994 dollars per unit)

							
	↓ 2.7%	↑ 1.2%	↓ 5.1%	↓ 2.0%	↓ 2.8%	↓ 4.1%	↓ 2.5%
	Kilowatthour	Thousand Cubic Feet	Barrel	Barrel	Short Ton	Short Ton	Barrel
1991	\$.050	\$2.56	\$35.36	\$17.24	\$45.65	\$121.78	\$18.74
1994	\$.046	\$2.65	\$29.92	\$16.20	\$41.85	\$106.89	\$17.31








Manufacturers Bought More Energy for Most of the Purchased Energy Sources








(physical units)

							
	↑ 4.3%	↑ 4.5%	↑ 2.0%	↑ 3.2%	↑ 3.5%	↑ 21.1%	↓ 0.9%
	Million Kilowatthours	Billion Cubic Feet	Thousand Barrels	Thousand Barrels	Thousand Short Tons	Thousand Short Tons	Thousand Barrels
1991	697,553	5,713	24,442	61,475	78,616	9,340	336,791
1994	788,070	6,490	25,939	67,343	86,920	15,259	328,117

Manufacturers Spent More Dollars for Some of the Purchased Energy Sources

(million 1994 dollars)

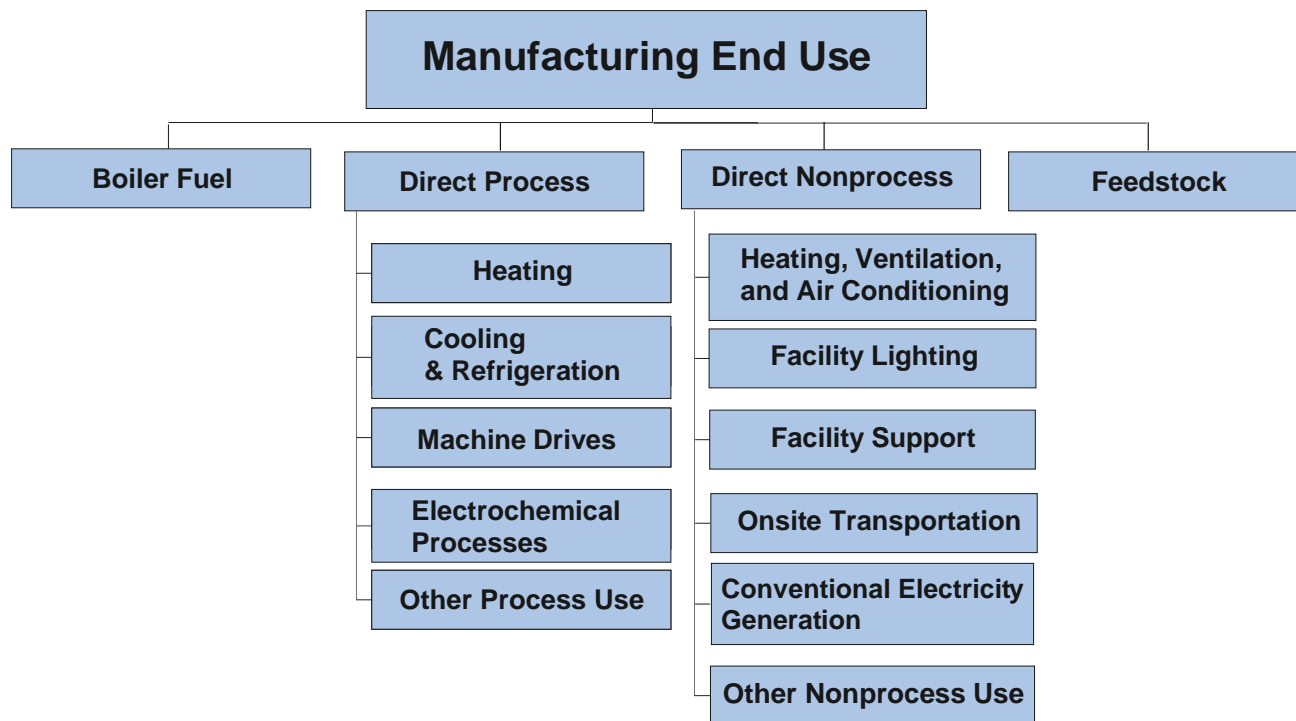
							
	↑ 1.3%	↑ 5.9%	↓ 3.4%	↑ 1.0%	↑ .05%	↑ 14.5%	↓ 3.3%
1991	\$34,638	\$14,630	\$864	\$1,060	\$3,589	\$1,137	\$6,311
1994	\$35,970	\$17,216	\$776	\$1,091	\$3,638	\$1,631	\$5,681

Legend	Electricity	Natural Gas	Distillate Fuel Oil	Residual Fuel Oil	Coal	Coke and Breeze	Liquefied Petroleum Gas
							

Notes: ●All percents were calculated at an annualized rate change. ●Nominal dollars were converted to real 1994 dollars using the chain-type indexes for Gross Domestic Product (1992=1.0) as published by the U.S. Department of Commerce, Bureau of Economic Analysis. See the glossary for a detailed definition of "real dollars."

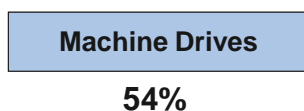
Source: Energy Information Administration, 1991 and 1994 Manufacturing Energy Consumption Surveys.

○ How Do Manufacturers Use Energy?

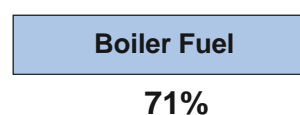


Major End Uses of Some Common Energy Sources (Percent of the Energy Source Used for the Particular End Use)

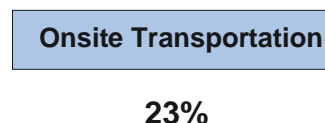
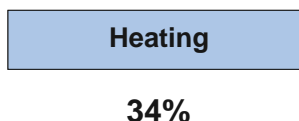
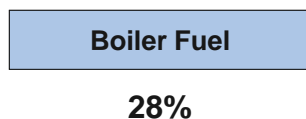
Electricity



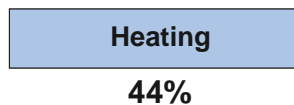
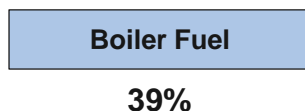
Residual Fuel Oil



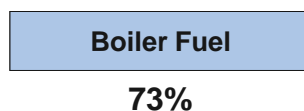
Distillate Fuel Oil



Natural Gas



Coal



Note: Calculations are based on the energy measure "Total Inputs of Energy for Heat, Power, and Electricity Generation."

○ What Important Changes Took Place From 1991 to 1994?

Electricity Use Increased



↑ 12% All Manufacturing

↑ 17%



Chemical Industry

↑ 13%



Petroleum Refining Industry

Net Electricity Increased

Between 1991 and 1994, the manufacturing sector increased use of net electricity by 12 percent. Most of this increase was in two industries--the chemical and petroleum refining industries. Leading the 17-percent growth in the chemical industry was an increase in the use of machine drives. Net electricity for machine drives increased by 9 percent. The petroleum refining industry displayed similar results. Leading the 13-percent growth in net electricity was a 9-percent growth in the use of electricity for its machine drives.

Trends in Onsite-Electricity Generation

Cogeneration ↑ 12%
(Energy sources used include fossil fuels, wood, and other biomass.)

Renewables Used To Generate Electricity by Means Other Than Cogeneration ↓ 34%

Onsite-Electricity Generation Increased, While the Use of Renewables to Generate Electricity Declined

In both 1991 and 1994, 84 percent of manufacturing electricity demand was produced outside of the establishments, while the other 16 percent was generated onsite. What did change was the mix in the sources and the amount of onsite-generated electricity. The manufacturing sector experienced a sizable decline (34 percent) in the amount of electricity generated onsite using renewable energy (excluding wood and other biomass which is represented in cogeneration). During the same time, total onsite-generated electricity increased by 10 percent. The increase was driven by a 12-percent rise in the amount of cogenerated electricity--the dominant subcategory of onsite-generated electricity, although the share of cogenerated electricity in electricity demand remained at 14 percent.

Trends in Feedstock Energy Use

Residual Fuel Oil



↓ 20%

Natural Gas



↑ 18%

The paper industry has historically been dominant in using renewable energy (mainly hydropower) to generate electricity onsite. In fact, the paper industry's share of manufacturing self-generation from renewables rose from 64 percent in 1991 to 85 percent in 1994, even though the amount of renewables-based generation in the paper industry dropped by 13 percent during that period. Obviously, the estimated amount of renewables-based electricity decreased drastically in other industries. However, data suppression for confidentiality protection prevents analysis of those other industries.

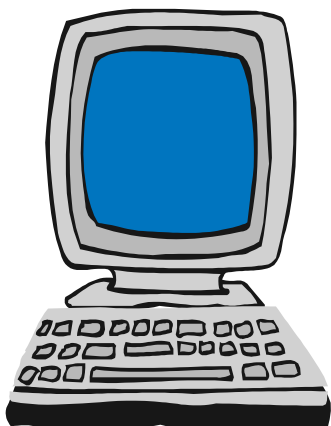
Use of the Byproduct Petroleum Coke Grew



↑ 40% All Manufacturing

The MECS does not provide data on the reasons for the decline in hydropower. However, several legal and market developments during the 1991 to 1994 period may have caused some existing operations to be shut down and prevented new investments in hydropower. During that time period, there was an unusual number of hydropower projects up for license renewal by the Federal Energy Regulatory Commission; hydropower generators were aging, and low-priced imported electricity became readily available along the Great Lakes. In May 1994, the U.S. Supreme Court held that States may impose conditions on hydroelectric operations as part of their authority under the Clean Water Act of 1977 and new water quality initiatives were anticipated such as the Great Lakes Water Quality Initiative (officially released in March 1995--6 years after the start of negotiations). Additionally, earlier this decade, wood supply was severely constricted in the Northwest. As a result, some paper industry establishments moved to the South where there are very limited amounts of hydropower.

- **What Are Some of the Most Important Changes That Took Place in Energy Management Activities From 1991 to 1994?**



Computer Control of the Building Environment (e.g., lights, air conditioning)

This technology was used in establishments that accounted for 5.1 quadrillion Btu in 1994.

↑ 65%

Computer Control of Processes or Major Energy-Using Equipment (e.g., boilers)

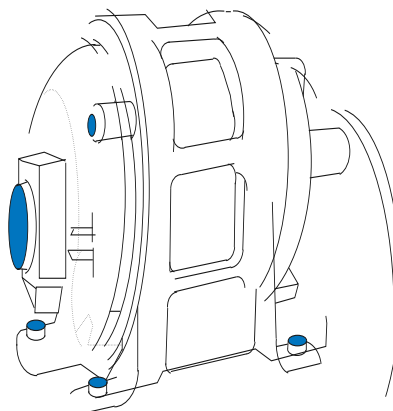
This technology was used in establishments that accounted for 12.1 quadrillion Btu in 1994.

↑ 18%

Adjustable-Speed Motors

This technology was used in establishments that accounted for 11.3 quadrillion Btu in 1994.

↑ 31%



Participation in at Least One Energy Management Program (e.g., utility, government, or self sponsorship)

Establishments participating accounted for 12.6 quadrillion Btu in 1994.

↑ 17%



Participation in at Least One Equipment Rebate

Establishments participating accounted for 2.5 quadrillion Btu in 1994.

↑ 220%